Bellcomm

955 L'Enfant Plaza North, S.W.
Washington, D. C. 20024

date: June 24, 1971

to: Distribution

from: W. W. Hough

B71 06042

subject: Contingency EVA on Skylab
Case 620

ABSTRACT

If it becomes impossible to use the Skylab Airlock for a nominal EVA, contingency modes of operation are possible. A two-man EVA to the ATM can be conducted using the oxygen, water, and electrical umbilical connections in the STS on the MDA-end of the Airlock, with egress through the Gemini hatch, if useable, or through the MDA spare docking port. A one-man, gas cooled EVA from the CM IVA station through the CM hatch is possible if sufficient oxygen remains in the SM cryo tanks to provide the required flow rate. The selection of a contingency mode of EVA depends on the failure that prevents nominal operation.

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MEMORANDUM FOR FILE

If it becomes impossible to use the Skylab Airlock for EVA, ATM film retreival is still feasible. Anomalies which would prevent use of the Airlock include inability to open the Gemini hatch, or a failure of the oxygen system in the Airlock. The other external hatches on Skylab are the CM side hatch and the spare MDA docking port hatch. Both offer possibilities, depending on the circumstances of the failure and status of the SM cryogenic O_2 system, for a contingency EVA.

EVA from the CM

A contingency EVA from the CM is possible only if there is enough oxygen in the SM cryo tanks to maintain a 9 lb/hour flow rate, or preferably 13 lb/hr, to the CM throughout the duration of the EVA.* It would be carried out in much the same fashion as the nominal Apollo 15 EVA. The CM cabin would be used as an airlock. All crew members would be in pressurized suits and would be supported by CSM systems. The single forty-foot oxygen/electrical umbilical that connects the Skylab EVA pressure control unit (PCU) at the suit to the single CM IVA station would limit the EVA to a one-man operation. The EVA astronaut would wear a Skylab secondary oxygen pack (SOP) on his leg for emergencys. As there is no water cooling capability in the CSM, oxygen circulation and purge would be the primary means of cooling. The other two crewmen would be supported by low-pressure umbilicals connected to the CM cabin suit loop. In the event of an emergency requiring rescue of the EVA crewman, the second

*A study of the cryogenic O_2 system for Apollo 15[1] shows that 10 lb/hr can be delivered from both tanks if the quanity of oxygen remaining is at least 16.5% of capacity without violating tank heater upper temperature limits or sounding the C&W alarm for low tank pressure (800 psia).

crewman would have to use another SOP and PCU combination. Two sets of this equipment would therefore have to be brought into the CM cabin and donned before an EVA. Dual low-pressure oxygen inlet connectors on the A7L-B pressure garment assembly (PGA) permit simultaneous connection to the PGA from the CM suit loop and the PCU, so in the event of an emergency the second crewman could transfer from the CM supply to the SOP supply without breaking the suit inlet connections (i.e. avoid vacuum transfer). The four pounds of useable oxygen in the SOP provides a minimum of 18 minutes of operation at the maximum flow rate through the PCU of 13 lbs/hr.

There is currently in Apollo a 60 minute CM hatch-open constraint that evolved from 2 TV-2 thermal vacuum tests[2]. The curved hatch tends to straighten because of temperature differences between the aluminum and ablator faces, and the aluminum face tends to expand and outgrow the size of the hatch opening. MSC has asked NR to investigate the possibility of extending the 60-minute constraint and it is likely that it will be extended. One-to-two hours is less than scheduled for a normal EVA, but a contingency EVA would include only ATM film retreival-not replacement.

The traverse route from the CM hatch to the forward-end and side stations of the ATM would have to be worked out in detail. Umbilical length (40 feet) is sufficient to reach both stations via the space between the MDA and ATM, and the normal EVA route along the side of the ATM. Existing handrails at the top of the MDA and the deployment assembly trusses would be used for handholds between the CM and the normal EVA rails. Another route along the CM side of the ATM and across the forward end is a possibility. This route has the advantage that a tether could be taken along for a direct-line pull in of canisters by a crewman inside the CM, but the disadvantage of less handholds.

EVA from the MDA

Two sets of oxygen, water, and electrical umbilical connections are located in the STS and are functionally identical to the EVA connectors in the lock. If the Gemini hatch is useable and the failure preventing a nominal EVA permits use of these connections, but not the connectiors in the lock, a fairly normal two-man EVA can be performed through the Gemini hatch using the MDA as an airlock. Examples of such failures include blockage of the fluid lines between the STS and lock connections, interuptions of electrical lines between the same points, and inability to pressurize the lock section. If the Gemini hatch cannot be opened, these connections can still be used to perform a two man EVA through the spare docking port on the MDA. A 60 foot umbilical is just long enough to reach the sun-end ATM work station if the traverse is made around the MDA cylinder on

the same side as the side work station of the ATM, and inside of the ATM deployment assembly (DA) truss members. The truss can be used for handholds until the astronaut reaches the normal EVA handrails on the DA. The second crewman would go to the outside of the Gemini hatch to operate the canister STEM retrieval mechanisms. The clothes line retrieval mechanism could then be strung from that station to the MDA docking port and the canisters pulled in.

Summary

The selection of a contingency mode of operation depends on the faiure mode that prevents a nominal EVA. If the failure precludes use of the lock umbilical connections but the Gemini hatch can be opened, then the STS connectors would be used with the MDA or MDA-plus-lock serving as the airlock. If the Gemini hatch cannot be opened, then the same connections can be used and the EVA performed through the side docking port. If the failure is in the Airlock oxygen system such that none of the 60 feet umbilical connections can be used, a one-man EVA can be conducted from the CM if sufficient oxygen remains in the SM cryo tanks. A failure in the Airlock water suit cooling system would not influence the selection of the CM because the CM has no water cooling capability, and the AM can provide gas cooling at the same flow rates as the CM.

If these possibilities for a contingency EVA are deemed worthy of further study, detailed procedures can be worked out with the help of the full scale mock-ups and neutral bouyancy test equipment at MSFC. No recommendation for further work is offered as the author can not evaluate the likelihood of the failures that would prevent a nominal EVA or perform the trade off between a load of ATM film and the additional risk associated with a contingency operation.

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REFERENCES

1. J. A. Saxton, "Apollo Oxygen Tank Performance Presentation", Bellcomm Memorandum for File, June 14, 1971.

2. G. J. McPherson, Jr., "A Brief Review of the Current CM Hatch-Open Constraint", Bellcomm Memorandum for File, April 14, 1971.